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<b>(54) Title:</b> METHOD FOR DETERMINING FORCED CHOICE CONSUMER PREFERENCES BY HEDONIC TESTING  <b>(57) Abstract</b>  The present invention recognizes and takes advantage of the fact that there is a correlation between a consumer's overall like or dislike of two particular products (hedonic test results), each evaluated individually, and the likelihood that the consumer will choose one product over the other (forced choice test results) in a forced choice comparison. Taking advantage of this correlation, it is possible to determine the likelihood that a consumer will choose one product over another product of the same type simply by conducting hedonic testing and without specifically conducting forced choice testing.		

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METHOD FOR DETERMINING FORCED CHOICE  
CONSUMER PREFERENCES BY HEDONIC TESTING

Field of the Invention

The invention relates to consumer testing in general  
5 and, more particularly, to consumer preference testing.

Background of the Invention

In consumer testing, e.g., testing that a company  
conducts to determine how well its product will be  
received by the intended consumer group, there are a  
10 number of different testing protocols that are followed.  
In hedonic testing, a consumer is presented with product  
samples, e.g., salty snacks such as pretzels or potato  
chips; cookies; toilet paper; etc., and is asked to  
evaluate each of several different products of a given  
15 type on a number of different qualities or product  
characteristics. For example, the test subject may be  
asked to evaluate potato chips for saltiness, flavor,  
appearance, texture, "mouth feel," etc.

When conducting hedonic testing, it is customary to  
20 have the test subject rate each parameter on a Likert  
scale, i.e., a scale having discrete integer values  
ranging from a low value (e.g., disliked extremely) to a

high value (e.g., liked extremely). Likert scales for hedonic testing typically require a response from 1 to 5, 1 to 7, or 1 to 9. For consumer testing of food products, a nine-point Likert scale customarily is used, with a response of 9 indicating that the consumer liked the particular quality being evaluated extremely; a response of 8 indicating that the consumer liked the quality being evaluated very much; 7 indicating that the consumer liked it moderately; 6 indicating that the consumer liked the quality slightly; 5 indicating that the consumer neither liked nor disliked the quality; 4 indicating that the consumer disliked the quality slightly; 3 indicating that the consumer disliked it moderately; 2 indicating that the consumer disliked it very much; and 1 indicating that the consumer disliked the quality being evaluated extremely. In addition to evaluating the individual qualities, the test subject typically is asked to provide a Likert scale rating indicating how well he or she liked the product overall, i.e., taking into account all factors or qualities which he or she has been or will be asked to evaluate.

Usually, the test subject is asked to indicate his or her liking or evaluation of the same characteristics or qualities of several products of the same type, e.g., several brands of pretzels or cookies. In sequential monadic testing, the consumer provides a complete evaluation for a given product before providing a complete evaluation for another product. In other words, a consumer testing potato chips, for example, indicates his

or her liking of the taste, crunch, saltiness, aroma, and overall liking of brand X potato chips, then indicates his or her liking of the taste, crunch, saltiness, aroma, and overall liking of brand Y potato chips. (This is in contrast to having a consumer provide a response for, e.g., the taste of brand X, then the taste of brand Y, then the crunch of brand X, then the crunch of brand Y, then the saltiness of brand X, then the saltiness of brand Y, etc.)

Finally, when the consumer has completed his sequential monadic evaluation of all the products being tested -- typically no more than three or four different products are tested in a given test setting -- the consumer is asked to indicate which of two given products he or she likes better, e.g., whether he likes W or X better; whether he likes W or Y better; whether he likes W or Z better; whether he likes X or Y better; whether he likes X or Z better; and whether he likes Y or Z better. This latter testing is referred to as forced choice testing, i.e., the consumer is forced to choose which product he or she prefers from among a forced selection of two possible products.

In certain situations, it is not possible or feasible to conduct forced choice testing, e.g., when the product flavors are so strong that tasting more than two products, or tasting the products a second time to select a preference, is precluded. Alternatively, time limitations may be such that adding the task of additional forced-choice comparisons among all combinations of products is

unreasonable and/or excessive. Thus, in such situations, it may be difficult to obtain meaningful forced choice data. For example, as the number of products being evaluated increases, so too does the number of possible forced choice pairings, but at a faster rate than the number of products increases. Other difficulties or problems with forced choice testing include the following: 1) the most accurate and reliable product assessment generally is considered to be the initial reaction to the product, not a response that comes after answering questions about individual taste, appearance, and texture details, etc.; 2) the respondents' decreasing memory of the samples becomes problematic if the samples are not available for re-sampling, but sensory fatigue (overload of the taste senses) becomes an issue if they are; and 3) the last product seen and sampled and the last question asked may influence the preference unevenly.

#### Summary of the Invention

In the present invention, we have recognized and taken advantage of the fact that there is a correlation between a consumer's overall like or dislike of two particular products (hedonic test results), each evaluated individually, and the likelihood that the consumer will choose one product over the other (forced choice test results) in a forced choice comparison. Thus, it is possible to determine the likelihood that a consumer will choose one product (product A) over another product (product B) of the same type simply by conducting hedonic

testing and without specifically conducting forced choice testing.

Thus, according to a first aspect of the invention, a method is provided for determining forced-choice preference information from hedonic test data. The method entails obtaining a test group of human test subjects and providing each of the test subjects in the group with two or more test samples. The test subjects are asked to sample each of the two or more test samples and provide hedonic test data indicative of how well they liked each of the test samples. The hedonic test data is then processed from all of the test subjects to determine at least one predicted forced choice preference result, the predicted forced choice preference result being indicative of the likelihood that a test subject would select one of the test samples over another one of the test samples in a forced choice comparison between a selected pair of test samples.

In a preferred embodiment of the method of the invention, of a pair of test samples being compared, a stronger test sample and a weaker test sample are determined. For each test subject, an overall-liking difference value is determined, the overall-liking difference value being based on the overall-liking value the given test subject assigned to the stronger test sample minus the overall-liking value the given test subject assigned to the weaker test sample. Then, for each possible overall-liking difference value, the number of occurrences of that possible value is determined. For

each possible overall-liking difference value, the number of occurrences of that value is multiplied by a probability coefficient to determine a corresponding subset number which represents the number of test subjects in a correlative, proportionate subset of the test subjects yielding that particular possible overall-liking difference value that would choose the stronger test sample over the weaker test sample in a forced choice comparison between the two. The subset numbers corresponding to each of the possible overall-liking difference values are then totaled to determine the total number of test subjects who would choose the stronger test sample over the weaker test sample in a forced choice comparison between the two. The preference for the stronger test sample may then be expressed by dividing the total number of subjects who would choose the stronger test sample over the weaker test sample in a forced choice comparison by the number of test subjects in the whole test group.

Preferably, the stronger test sample is the one of the two samples being compared with the larger average or mean overall-liking value. Furthermore, it is preferable for the hedonic test data to be obtained in integral, Likert scale format such that the overall-liking difference value, which equals the overall-liking value for the stronger test sample minus the overall-liking value for the weaker test sample, falls within a range of discrete integer values.



Thus, by utilizing the method according to the invention, the drawbacks to forced choice comparison testing noted above are substantially avoided.

#### Description of the Drawings

5           Fig. 1 is a graph showing the correspondence between actual measured preference proportion values and preference proportion values determined by logistic regression analysis thereof; and

10           Figs. 2 and 3 are scatterplots showing the error between predicted preference values and actual preference values for consumer tests used to develop the model of the invention and to test the model, respectively.

#### Detailed Description of the Invention

15           As noted above, the invention recognizes and takes advantage of the fact that there is a correlation between the hedonic test score a test subject gives for the overall likability of each of two different products and the likelihood that the test subject will choose one product over the other. Specifically, we have discovered  
20           that the greater the difference in overall liking of two different products (as measured on a hedonic scale), the greater the probability that a test subject (i.e., a consumer) will choose, in a forced choice preference situation, the product to which he or she assigned the  
25           greater overall liking score.

For purposes of understanding our invention, we believe it is preferable to explain or demonstrate how our

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approach is used in practice, and then to explain how the model we use in our method was developed.

#### Conducting the Testing

First, a number of respondents or test subjects that  
5 is large enough to obtain accurate product evaluation  
scores, i.e., on the order of sixty to one hundred twenty,  
is determined according to standard statistical analysis  
and consumer testing protocols and obtained. When  
conducting the tests, each respondent is asked to evaluate  
10 two or more samples of the same type of product, e.g., two  
or more different brands of potato chips, cookies, bagels,  
etc. To ensure meaningfulness of the test results, it is  
generally necessary that the respondents be users of the  
specific products or product category being tested. The  
15 respondents evaluate one sample at a time, completing a  
questionnaire for each sample before evaluating the next  
product. In other words, the testing is conducted in  
sequential monadic fashion. The products should not be  
labeled or branded, i.e., there should be "blind"  
20 presentation of the samples. The serving order should be  
balanced, i.e., each possible serving order should be used  
equally. If this is not possible, each sample product  
should be presented as the first sample an equal number of  
times.

25 The first survey question should ask about the  
respondent's overall liking of the product and, for food  
products, for example, may be worded along the lines of  
"Considering everything about this sample -- appearance,  
flavor, and texture -- how well do you like it overall?"

The respondent provides his or her response, preferably on a nine point Likert scale as described above. The respondent may then be asked a number of other questions pertaining to specific attributes of the product. No  
5 forced choice preference question is asked.

Once all respondents have been tested, forced choice preferences are determined as follows. First, the average overall-liking score for each product (the sum of all respondents' overall-liking scores for a given product  
10 divided by the total number of respondents) is calculated. Two different products for which it is desired to calculate the forced choice preference are then selected. Of these two products, the one having the larger average overall-liking score is designated the "stronger product"  
15 (or "product A"), and the other is designated the "weaker product" (or "product B").

The overall-liking difference between product A and product B is then determined for each respondent by subtracting each respondent's product B overall-liking  
20 score from his or her product A overall-liking score. Because the preferred scale is a 1-9 Likert scale on which only integer responses are possible, the overall-liking difference for each respondent will range from a highest possible value of 8 (indicating that the particular  
25 respondent liked product A extremely and assigned it an overall-liking value of 9 and disliked product B extremely and assigned it an overall-liking value of 1) to a lowest possible value of -8 (indicating that the particular

respondent liked product B extremely and disliked product A extremely).

Once all respondents' overall-liking difference values have been determined for each of the two products being compared, a "frequency table" is developed, i.e., the number of respondents demonstrating each of the possible overall-liking difference values (product A overall-liking value minus product B overall-liking value) is determined. This is shown by the information in column 1 (overall-liking difference, product A over product B) and column 2 (number of respondents yielding a particular overall-liking difference value) in Table I below, which presents an exemplary set of data. The respondents' specific overall-liking scores are not important -- just the difference between them. Thus, a respondent who gives product A an 8 and product B a 6 is counted in the "2 bucket" of the "frequency table" to the same extent a respondent who gives product A a 5 and product B a 3 is.

	(1) Overall-Liking Difference	(2) Number of Respondents	(3) Probability Coefficient	(4) Portion Preferring A
5	-8	1	0.00004	0.00004
	-7	0	0.00015	0.00000
	-6	4	0.00051	0.00204
	-5	5	0.00176	0.00880
	-4	3	0.00608	0.01824
10	-3	10	0.02076	0.20760
	-2	12	0.06849	0.82188
	-1	15	0.20316	3.04740
	0	20	0.53073	10.61460
	1	10	0.79684	7.96840
15	2	12	0.93151	11.17812
	3	9	0.97924	8.81316
	4	9	0.99392	8.94528
	5	8	0.99824	7.98592
	6	0	0.99949	0.00000
20	7	1	0.99985	0.99985
	8	0	0.99996	0.00000
		<b>total respondents: 119</b>		<b>Total preferring product A: 60.61; Preference for product A: 50.93%</b>

Table I

After determining the number of respondents (Col. 2) yielding each possible overall-liking difference value (Col. 1), the number of respondents for each overall-liking difference value is multiplied by an empirically derived probability coefficient (Col. 3) to obtain, for each overall-liking difference value, the portion or

subset of respondents who would prefer the stronger product, i.e., product A. (The manner in which the probability coefficients are determined is described below.) Thus, each probability coefficient represents the likelihood that a given respondent, for whom the difference between his or her overall-liking of product A and product B is a particular value, would prefer product A to product B if forced to choose between the two.

In other words, referring to exemplary Table I, out of 100,000 people each yielding an overall-liking difference of, for example, -8 (i.e., they disliked product A extremely and assigned it an overall-liking value of 1, but liked product B extremely and assigned it an overall-liking value of 9), only four seemingly would contradict their respective ratings and choose product A over product B when forced to chose between the two. On the other hand, out of 100,000 respondents for each of whom the overall-liking difference value is 8 (i.e., they liked product A extremely and gave it an overall-liking value of 9, but disliked product B extremely and gave it an overall-liking value of 1), 99,996 actually would choose product A over product B when forced to choose between the two. Hence, the number of respondents yielding a given overall-liking difference value multiplied by the probability coefficient for that overall-liking difference value yields the portion or subset of that group of respondents that would choose product A over product B in a forced choice comparison between the two (mindful of the fact that fractional

numbers of people cannot exist, but realizing that, for much larger test populations than the 119 respondents whose test results are reflected in Table I, "fractional people" become negligible).

5           (With respect to the probability coefficient corresponding to an overall-liking difference of zero, one might expect the probability coefficient to be 0.5000, indicating that half the population would select product A in a forced choice scenario and half the population would  
10 select product B in a forced choice scenario. The fact that this is not the case is believed to result from the fact that the probability coefficients are determined by curve-fitting empirical data, as explained below. It is also believed to reflect the fact that the Likert scale is  
15 discrete, i.e., it permits only integer values to represent the respondents' like or dislike of a given product, whereas a continuous scale would have allowed the respondents to show slightly greater or slightly less like of one product, which would be consistent with the  
20 slightly greater preference for product A represented by the probability coefficient being slightly greater than 0.5000.)

After the portion or subset of respondents that would select product A over product B is determined for each  
25 overall-liking difference value (Col. 4), the portion values are totaled to obtain the total number of respondents that would select product A over product B in a forced choice comparison. With respect to Table I, it is predicted that 60.61 respondents out of the 119 whose

sample test data are reflected in Table I would have chosen product A over product B in a forced choice comparison. This represents a 50.93% preference for product A ( $60.61 \div 119$ ) or, in other words, 5,093  
5 respondents out of 10,000 would select product A over product B in a forced choice comparison.

It should be appreciated that this methodology can be used to predict the likelihood that any one product selected from a group of several sample products will be  
10 selected over any other product selected from the same group of sample products without actually having to conduct the various permutations of forced choice comparisons. The limit, if any, of the number of sample articles for which such forced choice comparison data can  
15 be calculated meaningfully from the Likert scale test data is not presently known.

#### Determination of Probability Coefficients

As noted above, the probability coefficients used in the method are empirically derived. To develop the set of  
20 probability coefficients (Column 3 of Table I above) and to verify the accuracy of this novel approach to determining forced choice preferences, fifty-six central location tests were conducted covering a wide range of snack food-type products, namely, potato chips, novelty  
25 puffs, tortilla chips, dip/salsa, seasoned tortilla chips, tortillas, and multi-grain chips. The number of tests and the number of test subjects (respondents) for each type of



product tested for purposes of developing the probability coefficients is indicated in Table II below.

	Product Type	Number of Tests	Number of Subjects
	potato chips	6	702
5	novelty puffs	1	119
	tortilla chips	2	233
	dip/salsa	5	559
	seasoned tortilla chips	1	118
10	tortillas	3	313
	multi-grain chip	2	236

Table II

In each test, between sixty and one hundred twenty-one respondents evaluated two different product samples. Samples were served in plain white soufflé cups coded with the same three-digit number for both the hedonic scale and the preference questions. The test subjects answered the hedonic scale questions with the samples presented in sequential monadic fashion, balanced for presentation order. When being asked the forced choice preference question, respondents were presented with the same two sample products simultaneously, with an opportunity for re-tasting if desired.

Variables that differed between samples being compared included product brand, line quality product versus gold standard product, different oils and/or

seasonings, and even a new fryer configuration versus an older fryer configuration. The large variety of products and test conditions (test parameters) was used so that the conclusions from the modeling, i.e., the probability coefficients, would be more broadly applicable. In other words, the probability coefficients developed by the testing discussed herein probably could be used for all different types of snack food products, if not for all different types of food products in general. (We do not know, however, whether the probability coefficients disclosed herein could be used to obtain forced choice preference data for products that are quite different from snack food products, e.g., cars or televisions.) If the number of different products included in developing the probability coefficients was statistically small, the validity of our conclusions would be much more restricted.

The composite forced choice preference test results from the twenty different tests summarized in Table II then were processed to determine, for each possible overall-liking difference value, the number of test subjects who yielded that overall-liking difference value, as shown in Columns 1 and 2 of Table III below.

	Overall-Liking Difference Value	Number of Subjects	Subjects Choosing Product with Higher Overall-Liking Value	Proportion
	0	591	291	0.492
5	1	809	671	0.829
	2	442	419	0.948
	3	202	190	0.941
	4	115	114	0.991
	5	68	67	0.985
10	6	35	33	0.943
	7	15	15	1
	8	3	3	1

15 This is the number that chose the sample with the higher mean acceptability, i.e., the stronger product of the two being compared in any given forced choice comparison.

Table III

20 (The "Number of Subjects" might actually more properly be designated "Number of Occurrences" since it is the actual number of times a given overall-liking difference value occurred, and that particular value could have been demonstrated more than once by a given test subject or respondent if that test subject or respondent participated in more than one test, e.g., by testing more than one product type.)

25 The proportion of respondents (Column 4 of Table III) who, in the forced choice comparisons, chose the product to which he or she had assigned the higher overall-liking value was then determined by dividing the number of

subjects who, in the forced choice comparison, picked the product to which he or she had assigned the higher overall-liking value (Column 3 of Table III) by the number of subjects exhibiting the given overall-liking difference value (or the number of occurrences of that value), i.e., Column 2 of Table III. (Like the "Number of Subjects" demonstrating a particular overall-liking difference value (Column 2 of Table III), the "Number of Subjects Choosing the Product With the Higher Overall-Liking Value" (Column 3 of Table III) might also more properly be termed the number of occurrences of a test subject choosing the more well-liked product for the same reason explained above.)

Once the proportion (Column 4 of Table III) of subjects choosing, in a forced choice comparison, the product to which he or she assigned the higher overall-liking value was determined for each possible overall-liking difference value, a dose-response curve was determined using logistic regression analysis, with each overall-liking difference value constituting an abscissa or x-axis value and the corresponding proportion constituting the ordinate or y-axis value. (It should be noted that no negative overall-liking difference values were considered in this step of the analysis since the focus of the analysis at this point was on respondents who, in the forced choice comparison, chose the product to which they had assigned the greater overall-liking value, not the respondents who seemingly contradicted themselves and chose the product to which they had assigned the lower overall-liking value.) The linear logit regression model

(Agresti, 1990) was chosen to model or curve-fit this system because it is appropriate for logistic regression analysis when the response variable (the proportion who, in the forced choice comparison, chose the product to which they had assigned the higher overall-liking value) is binomial. (The response variable here was binomial in the sense that the subjects did or did not choose the sample to which they had assigned the higher overall-liking value.)

The linear-logit model can be written in general as:

$$\ln [p/(1-p)] = \alpha + \beta x, \quad (1)$$

where

p is the proportion choosing the higher overall-liking value product in the forced choice comparison (Column 4 of Table III), i.e., the response or y-axis value;

$\alpha$  is a constant;

x is the dose or abscissa value, i.e., the overall-liking difference value (Column 1 of Table III); and

$\beta$  is a coefficient of the x-axis variable.

The logistic regression procedure PROC LOGISTIC from the SAS statistical software package (SAS Institute, 1990) was then used to estimate the constant  $\alpha$  and the coefficient  $\beta$  in the equation above as  $\alpha = 0.1231$  and  $\beta = 1.2435$ . The model equation then becomes

$$\ln [p/(1-p)] = 0.1231 + 1.2435x \quad (2)$$

or,

$$p = \frac{e^{(0.1231 + 1.2435x)}}{e^{(0.1231 + 1.2435x)} + 1} \quad (3)$$

Equation (3), which was derived by curve-fitting empirically determined data, was then used to calculate the predicted proportion value for each of the non-negative overall-liking difference values, as shown in Column 3 of Table IV below. THESE ARE THE PROBABILITY COEFFICIENTS SHOWN IN COLUMN 3 OF TABLE I FOR THE NON-NEGATIVE OVERALL-LIKING DIFFERENCE VALUES (shown to three decimal places) AND USED IN ACTUALLY CONDUCTING A "LIVE" TEST AS DESCRIBED ABOVE.

Overall-Liking Difference Value	Measured Proportion (From Table III)	Predicted Proportion	95% Confidence Limits
0	0.492	0.531	0.493 - 0.568
1	0.829	0.797	0.776 - 0.816
2	0.948	0.932	0.915 - 0.945
3	0.941	0.979	0.970 - 0.986
4	0.991	0.994	0.990 - 0.996
5	0.985	0.998	0.997 - 0.999
6	0.943	0.999	0.999 - 1.000
7	1	1	0.9996 - 1.000
8	1	1	0.9999 - 1.000

Table IV

Column 4 of Table IV shows the 95% confidence limits for the predicted proportions in column 3 of Table IV. In other words, if this analysis were conducted one hundred times using one hundred independent sets of data, ninety-five of the calculated predicted proportions (column 3 of Table IV) would be between 0.493 and 0.560 for an overall

liking difference value of 0, for example. The same applies for each row of the table as well. Graphically, Figure 1 shows how close the predicted proportion values (calculated from Equation (3)) are to the actual  
5 proportion values as measured by the test data.

The predicted proportion values (Column 3 of Table IV) are then "extended" to cover negative overall-liking difference values by assuming "symmetry." In other words, because a negative overall-liking difference value  
10 indicates that a particular respondent assigned a higher overall-liking value to the weaker product or product B than to the stronger product or product A (recalling that the designation of one product as the stronger product (product A) and the other as the weaker product (product  
15 B) is based on the two products' relative average overall-liking values), the probability that a respondent for whom the overall-liking difference value is negative would choose product A in a forced choice comparison is assumed to be one minus the probability that a respondent for whom  
20 the overall-liking difference value is positive and of the same absolute value would choose product A in a forced choice comparison. To demonstrate this symmetry by way of an example, the predicted proportion corresponding to an overall-liking difference value of 2 is 0.932 (Column 3 of  
25 Table IV); the predicted proportion corresponding to an overall-liking difference value of -2 is  $1 - 0.932$ , or 0.068 as expressed to three decimal places.

Thus, the complete set of probability coefficients  
(representing the probability that product A would be

chosen over product B in a forced choice comparison) is shown in Table V to three decimal places, and these probability coefficients are the same probability coefficients shown in Table I, above, to five decimal places.

Overall-Liking Difference Value (Product A - Product B)	Probability of Product A Being Chosen		Overall-Liking Difference Value (Product A - Product B)	Probability of Product A Being Chosen
-8	0		1	0.797
-7	0		2	0.932
-6	0.001		3	0.979
-5	0.002		4	0.994
-4	0.006		5	0.998
-3	0.021		6	0.999
-2	0.068		7	1
-1	0.202		8	1
0	0.531			

Table V

Finally, the accuracy of our novel approach to deriving forced choice comparison information from hedonic testing data is illustrated in Figures 2 and 3. Fig. 2 is a scatterplot showing the difference between the actual (i.e., measured) forced choice comparison result and the predicted (i.e., calculated by our method) forced choice comparison result for each of the twenty tests summarized in Table II above and used to estimate  $\alpha$  and  $\beta$  in equation (1) above. In each case, the predicted value was for the



sample having the higher average overall-liking value, i.e., the stronger product or product A. Seventeen of the twenty actual forced choice preference values have 95% confidence intervals that extend so as to include the forced choice comparison results predicted by our model.

Moreover, because one reasonably would expect to see such close correlation when making the comparison using the tests on which the model coefficients were based, we also used our model to calculate forced choice comparison results for thirty-six additional central location tests, the results of which were not used in deriving the probability coefficients. Those thirty-six tests are summarized in Table VI below.

Product Type	Number of Tests	Number of Subjects
potato chips	7	813
cookies	6	639
tortilla chips	7	795
dip/salsa/picante	6	673
Mexican foods	3	268
tortillas	2	230
multi-grain chips	1	120
pretzels	4	427

Table VI

Fig. 3 is a scatter plot, similar to Fig. 2, showing for each of the thirty-six tests summarized in Table VI

the difference between the actual forced choice comparison result and the result predicted by our model. Thirty-three of the 95% confidence intervals for these thirty-six actual preference percentages extend so as to include the preference percentage predicted by our model. Thus, out of fifty-six total tests (20 used to generate the model and thirty-six used to "test" it), only six yielded predicted preference percentage values not within the 95% confidence interval of the actual test result value.

10 These discrepancies are almost completely accounted for by large deviations from a 50/50 split among subjects showing no difference in overall-liking values.

It will be appreciated by those having skill in the art that the concepts and methodologies disclosed herein can be extended in numerous ways, and such extensions of our approach are deemed to be within the scope of the following claims.

15

Claims

1. A method for determining forced-choice preference information, said method comprising:

- 5 obtaining a test group, said test group comprising a plurality of human test subjects;  
providing each of said test subjects with two or more test samples;  
causing each of said test subjects to sample each of said two or more test samples;  
10 obtaining from each of said test subjects hedonic test data indicative of how well each of said test subjects liked each of said test samples; and  
processing the hedonic test data from all of said test subjects to determine at least one predicted forced  
15 choice preference result, said at least one predicted forced choice preference result being indicative of the likelihood that a test subject would select one of said test samples over another of said test samples in a forced choice comparison of a pair of said test samples.

2. The method of claim 1, wherein said hedonic test data comprises overall-liking values assigned by each of said test subjects to each of said test samples, and wherein said processing comprises:

- 5 of said pair of test samples, determining a stronger test sample and a weaker test sample;  
for each of said test subjects, determining an overall-liking-difference-value, the overall-liking  
difference value for a given test subject being determined

10 based on the overall-liking value said given test subject  
assigned to the stronger test sample minus the overall-  
liking value said given test subject assigned to the  
weaker test sample and falling within a range of possible  
overall-liking difference values;

15 for each possible overall-liking difference value,  
determining the number of occurrences of the possible  
overall-liking difference value;

for each possible overall-liking difference value,  
multiplying the number of occurrences of the possible  
20 overall-liking difference value by a probability  
coefficient to determine a corresponding subset number for  
each possible overall-liking difference value, the subset  
number representing the number of test subjects in a  
correlative, proportionate subset of the test subjects  
25 yielding the possible overall-liking difference value that  
would choose the stronger test sample over the weaker test  
sample in a forced choice comparison of the two test  
samples; and

totaling the subset numbers corresponding to each of  
30 the possible overall-liking difference values to determine  
the total number of test subjects who would choose the  
stronger test sample over the weaker test sample in a  
forced choice comparison of the two test samples.

3. The method of claim 2, further comprising  
determining a percentage preference value by dividing the  
total number of test subjects who would choose the  
stronger test sample over the weaker test sample in a

5 forced choice comparison of the two test samples by the number of test subjects in the test group.

4. The method of claim 2, wherein said stronger test sample has an average overall-liking value and said weaker test sample has an average overall-liking value and wherein the stronger test sample is defined to be the test  
5 sample of the two having the larger average overall-liking value.

5. The method of claim 2, wherein said hedonic test data is obtained in integral, Likert scale format and wherein the overall-liking difference value for said given test subject equals the overall-liking value said given  
5 test subject assigned to the stronger test sample minus the overall-liking value said test subject assigned to the weaker test sample.

6. The method of claim 1, wherein more than two test samples are sampled by each of said test subjects and wherein predicted forced choice preference results are determined for more than one pair of test samples.

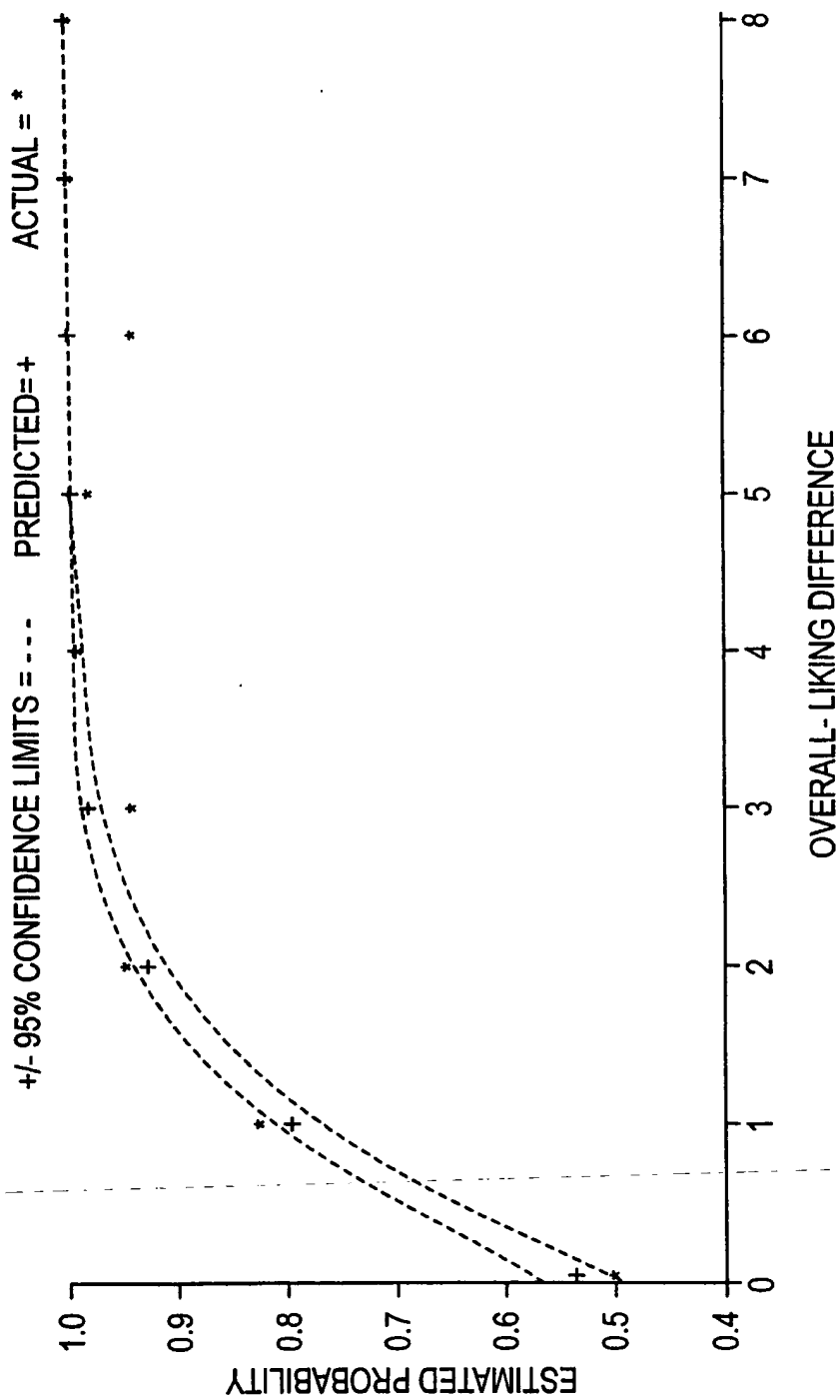


FIG. 1

2/3

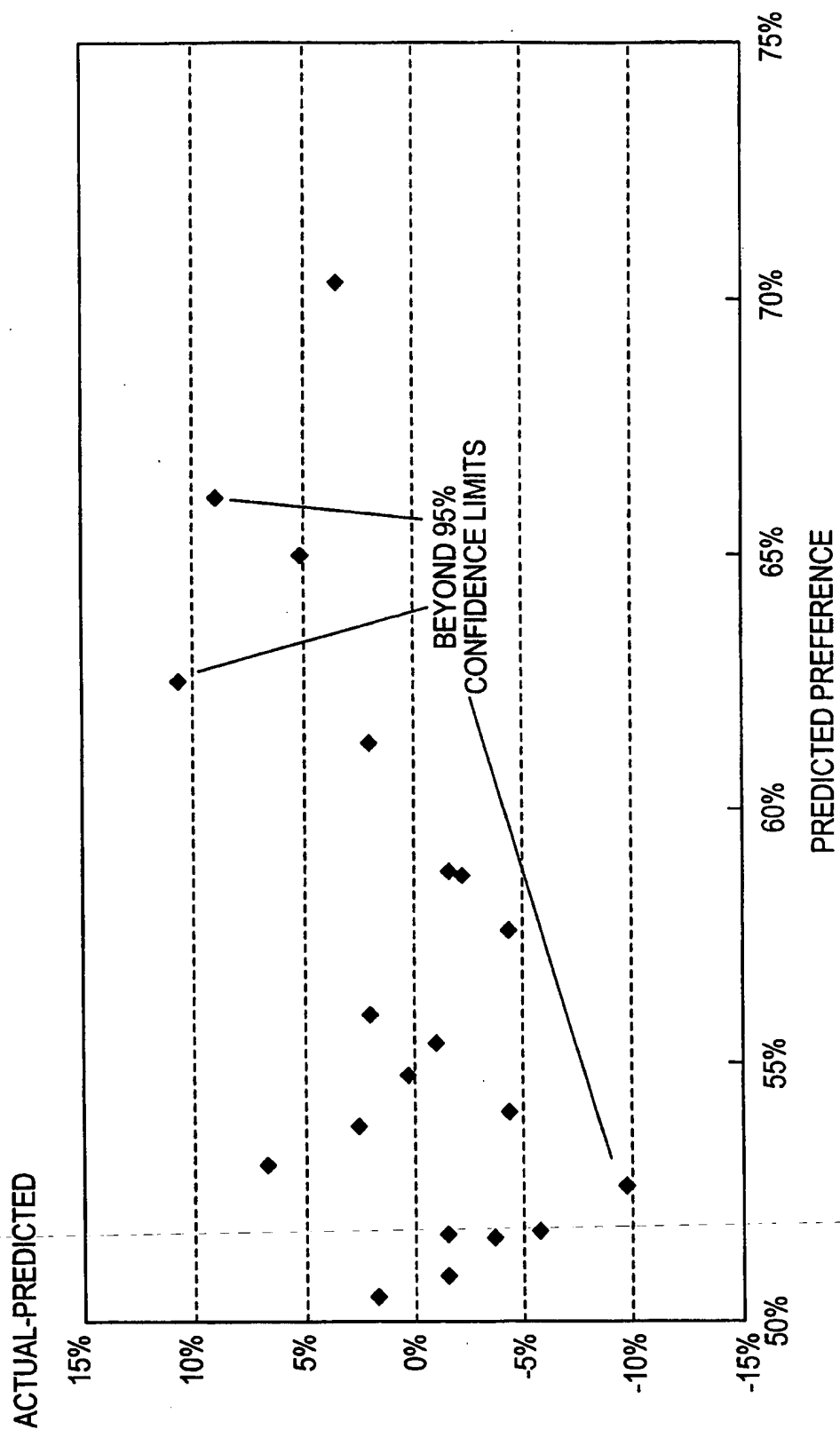


FIG. 2

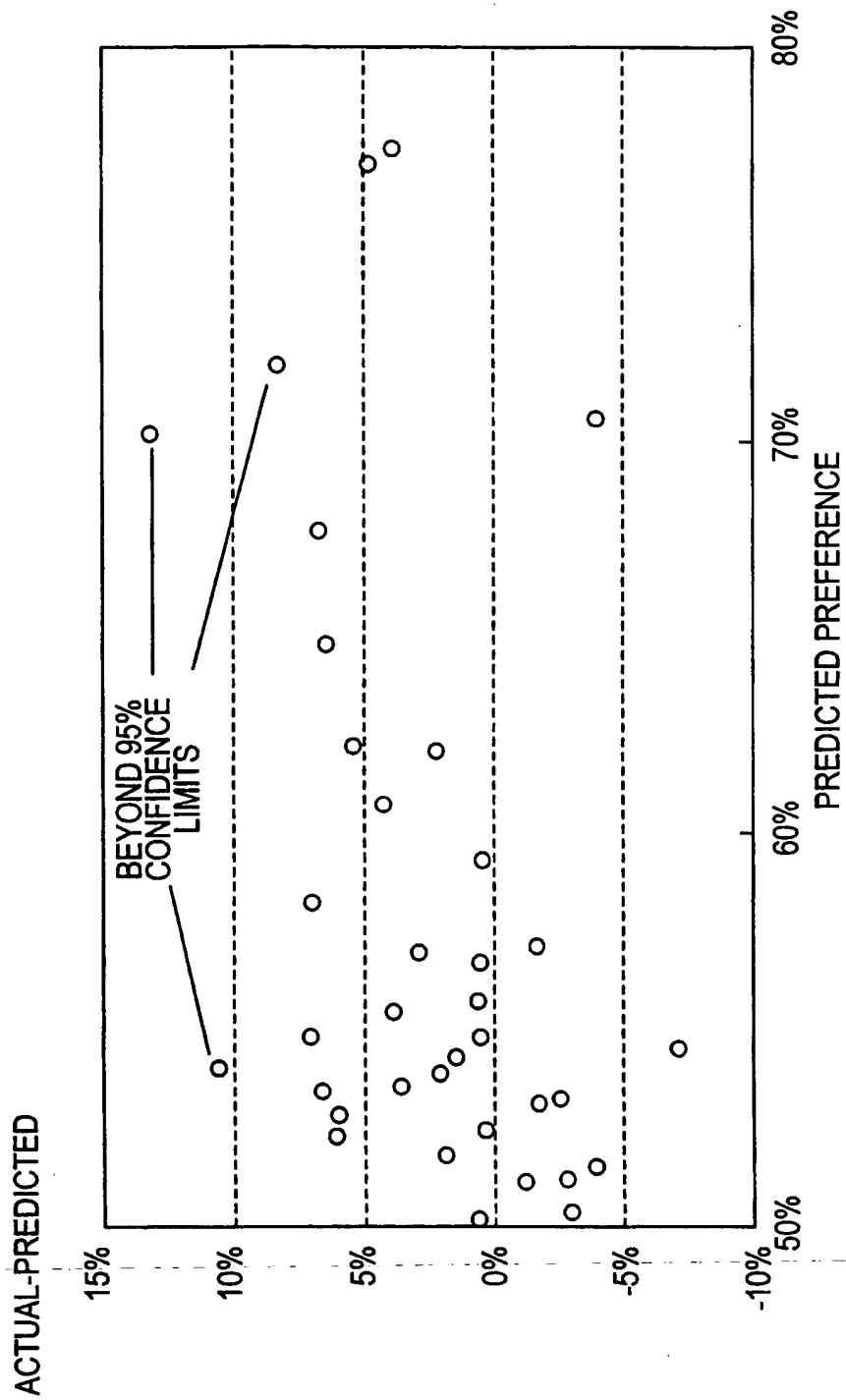


FIG. 3



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/18282

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 G01N33/02 G01N37/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LEA HYVÖNEN, ET AL.: "SWEETENING OF SOFT DRINKS WITH MIXTURES OF SUGARS AND SACCHARIN" JOURNAL OF FOOD SCIENCE., vol. 43, no. 5, 1978, pages 1580-1584, XP002089508 CHICAGO US see the whole document ---	1-6
A	A. VIE, ET AL.: "ALTERNATIVE HEDONIC MEASURES" JOURNAL OF FOOD SCIENCE., vol. 56, no. 1, 1991, pages 1-5, XP002089509 CHICAGO US see the whole document ---	1-6

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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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"&" document member of the same patent family

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Information on patent family members

International Application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5191896 A	09-03-1993	NONE	
US 4908758 A	13-03-1990	CA 1298663 A	07-04-1992
US 5090734 A	25-02-1992	NONE	